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Transient models of a displacement ventilation (DV) system and an underfloor air distribution (UFAD) system JONG KEUN YU, PAUL LINDEN, UCSD — Transient models of a displacement ventilation (DV) system and an underfloor air distribution (UFAD) system are examined theoretically and experimentally. We consider that a room heated by a single heat source represented as a buoyant plume and cooled with cooling diffusers. The cooling diffusers of DV system are assumed not to produce any appreciable mixing, while those of UFAD system are negatively buoyant jets which can mix warm air down from the upper part of the space. Conserving mass flux and buoyancy flux, the models determine the transient response of the temperatures in the lower occupied zone and the warm upper layer and the height of the interface between the layers. Non-dimensional transient models of DV and UFAD systems are derived by considering two competing time scales, the filling box time (Baines & Turner 1968) which provides a measure for the establishment of the stratification and the replenishment time in which all the air in the enclosure is replaced by supply air. The models are examined by laboratory experiments using a salt-water analogy. The experiments show good agreement with the theoretical predictions for the initial transients in which the heat source and diffusers start simultaneously, and the time-varying heat or cooling loads simulating dynamic thermal responses in a real building.

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